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Ergonomic Risk Assessment among Healthcare Laboratory Technicians in Benghazi Medical Centre

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ABSTRACT

Laboratory health-care technicians, including microbiologists, pathologist, chemists and etc, are exposed to a number of risk factors in the workplace for musculoskeletal disorders (MSDs). But, the individual effect of these risk factors on laboratory technicians in Libya is unknown. Objective: The aim of this study was to know the risk factors and its individual contribution for work-related MSDs (WMSDs) among laboratory technicians in health care system. Materials and Methods: Descriptive Cross-Sectional study, done on laboratory health-care technicians in Benghazi Medical Centre (BMC). Risk factors were categorized into personal and workstation which was known using questionnaire and RULA checklist. Outcomes: A total of 103 subjects participated randomly in the study. Data outcomes display that all the study participants are at ergonomic risk caused by static & repetitive working postures during laboratory tasks such as computer workstation and pipetting workstation that were found to be the most important contributory factors in WMSDs. Conclusion: Medical laboratory technicians are strongly encouraged to adopt preventive measures toward personal and workstation-related risk factors before symptoms of WMSDs develop.

Keywords: *Work-Related Musculoskeletal Disorders, Health Risk at Work, Laboratory Technicians at Health Care.*

1. INTRODUCTION

The blame that the work may adversely impact health is not new. For years ago, Musculoskeletal disorders (MSDs) have been diagnosed as a group of painful injuries and/or disorders that can affect the human body's movement or musculoskeletal system including muscles, tendons, ligaments, nerves, discs, blood vessels, etc. These injuries/disorders have received different names such as Repetitive Motion Injuries, Repetitive strain/stress Injuries, Cumulative Trauma Disorders, Occupational Cervicobrachial Disorders, Overuse Syndrome, Regional Musculoskeletal Disorders, Soft tissue Disorders, and many more.[1-3] There is a strong association between the incidence of WMSDs and the posture work, specifically the physical risk factors related to work including, awkward postures, high repetition, excessive force, static work, or vibration. Work stress and other psychosocial factors additionally appear to be factors that progressively contribute to the onset of those disorders.[3,4]

World Health Organization (WHO) attributes a multifactorial etiology to WMSDs, these disorders seem as consequence of the worker exposure to the different number of work-related risk factors". A risk factor is any source/situation with the potential to cause injury or lead to the development of a disease". [4] The variability and complication of these factors can describe the challenges often met in order to decide the best suited ergonomic intervention program to be applied in a certain workplace for controlling them. In order to measure WMSDs there are three groups of risk factors. These are:

a) Physical factors (Ergonomics): involving sustained or awkward postures, repetition of the same movements, forceful exertions, hand-arm vibration, all-body vibration, mechanical compression, and cold.

b) Psychosocial factors (Work Stress): involving work pace, autonomy, monotony, work/rest cycle, task demands, social support from colleagues and management and job uncertainty.

c) Individual factors: involving age, gender, professional activities/skills, sports activities (workers' fitness), domestic activities, recreational activities, alcohol/tobacco consumption and, previous WMSD.[5]

When workers are exposed to MSD risk factors, they begin to fatigue. If fatigue outruns their body's recovery system, they develop a musculoskeletal imbalance. Over time, as fatigue continues to outrun recovery and the musculoskeletal imbalance persists, a musculoskeletal disorder develops.[6] These risk factors can also be divided into two types: work-related ergonomic risk factors and individual-related risk factors.[7] The design of workplace plays an important role in the development of an Musculoskeletal disorders. For instance, if workers are asked to perform a job that is outside their body's capabilities and skills, they are being asked to put their musculoskeletal system at risk so, the workers are at risk of developing a musculoskeletal imbalance and a musculoskeletal disorder about to happen due to ergonomic and/or individual risk factors.

In healthcare system no doubt about the essential role of laboratory technicians in the effective management of diseases, as reports present that laboratory services play a role in as much as 60–70% of decisions related to hospital admission, prescribed medication, and discharges. This put the laboratory worker in extreme position in the fight against diseases.[8] However, in order to perform efficiently in this position, the health and safety of the laboratory worker at the workplace should be set most attention. The job of these technicians contains static and awkward working postures, high frequency and prolonged duration. Technicians perform various tasks including handling microscopes, pipetting, Bio analyzer activities etc. that consists continuous wrist bending, twisting, neck bending, thumb force when pressing plunger, pinch grips, standing for prolonged time and reaching too far from the body to get objects etc. All these factors can raise the risk of development of Work-related MusculoSkeletal Disorders (WMSDs).[7-9]

Thus, this study explores general ergonomic issues that may be a concern for any worker and specific ergonomic issues that are specifically related to the laboratory workplace. The study also disorders that are work-related. Therefore, ergonomics is much broader than preventing work-related musculoskeletal disorders. The successful application of ergonomics assures high productivity, avoidance of illnesses and injuries, and increased satisfaction among workers.

2. THE AIM OF THE STUDY

This study aims to conduct ergonomic risk assessment among health care laboratory technicians in order to identify the risk for development of Work-related Musculoskeletal Disorders among them.

3. LITUATURE REVIEW

OSHA (2011) mentioned that employers should recognize that laboratory workers are at risk for repetitive motion injuries during routine laboratory procedures e.g.; pipetting, working at microscopes, operating microtomes, using cell counters and keyboarding at computer workstations. Repetitive motion injuries develop over-time and occur when muscles and joints are stressed, tendons are irritated, and nerves are strained and blood flow is limited. Working in awkward positions in laboratory hoods/bio-safety cabinets can additionally present ergonomic issues. Consequently, employers can reduce occupational injuries and simultaneously develop worker comfort, productivity, and job satisfaction by becoming familiar with ways to control laboratory ergonomics-related risk factors.[8]

USA APHIS Ergonomics Program (2012), resulted that the percentage of medical problems reported with long-term microscope use by body part is (Neck 50-60%, Shoulders 65-70%, Back (Total) 70-80%, Lower Back 65-70%, Lower Arms 65-70%, Wrists 40-60%, Hands and Fingers 40-50%, Legs and Feet 20-35%, Eyestrain 20-50%, Headaches 60-80%). This program concluded that these potential hazards produced by poor posture and an unhealthy laboratory environment and recommended that the employer should act to eliminate WMSDs in the laboratory environment and enhance productivity. [9]

Another study conducted in the Philippine Science High School - Main Campus, shows that 86% of Grade 11 students have an environmental complaint on their chemistry laboratory. It has been evaluated through RULA/REBA techniques that 100% of common laboratory postures are unacceptable. Through additional analyses on the anthropometrics of the furniture and the environmental conditions in the laboratory, it has been established that overall ergonomic considerations for the Filipino senior high school students have been lacking. Accordingly, the study suggests applying the immediate change in laboratory design which features ergonomic laboratory tables, cabinets, white board and light and temperature control system.[10]

A study was done in India, among medical laboratory professionals, resulted that a total of 250 subjects participated in this study. Female paramedical staff in younger age was found to be at higher risk. Among various workstations, computer workstation and pipetting workstation were found to be the most important contributory factors in WMSD with people having 2.5 and 1.4 times higher risk of WMSD compared to people at no risk. This study concluded that laboratory professionals are strongly encouraged to adopt preventive measures toward personal and workstation-related risk factors before symptoms develop. [11]

In addition, a study was conducted among 279 laboratory technicians at King Fahd Hospital, Saudi Arabia, who filled in a self-administered questionnaire, including questions regarding their demographic criteria, occupational history, job tasks, workplace tools, ergonomic factors at work, and symptoms suggestive of Carpal Tunnel Syndrome (CTS). Physical examinations and electro-diagnostic studies were carried out for those who had symptoms suggestive of CTS to approve the diagnosis. Analysis was performed for both personal and physical factors in association with confirmed CTS among laboratory technicians. The prevalence of CTS among the laboratory technicians was 9.7% (27/279). The following were the statistically significant risk factors for CTS among them: gender (all cases of CTS were female, P = 0.00), arm/hand exertion (OR:7.96; 95% CI: 1.84–34.33), pipetting (OR:7.27; 95% CI: 3.15–16.78), repetitive tasks (OR: 4.60; 95% CI: 1.39–15.70), using un adjustable chairs or desks (OR:3.35; 95% CI: 1.23–9.15), and working with a biosafety cabinet (OR: 2.49; 95% CI: 1.11–5.59). CTS cases had significant longer work duration (17.9 ± 5.6 years) than CTS non-case (11.5 ± 7.4 yeas) with low OR (1.108). This study establishes some

personal and ergonomic factors associated with CTS among the laboratory technicians, including female gender, arm/hand exertion, pipetting, repetitive tasks, working with a biosafety cabinet, and an unadjusted workstation. [12]

Further studies documented that the static contraction posture over prolong period of time could lead to pain in neck and shoulder. Also mentioned that continuous looking down on microscope and on computer screen increases stress on eyes. Study have also shown that 41% of study subjects cannot adjust screen of their computer also 22% of study subjects have also reported that they don't find laboratory lighting sufficient for their work which also could lead to increase stress on eyes while working on microscope for prolong time.[13]

4. RESEARCH METHODOLOGY

- **Type of the study:** Descriptive (Cross-sectional) Study.
- **Study Place:** Medical Laboratories at Medical Benghazi Centre (BMC) in Benghazi City in Libya.
- **Target Group:** HealthCare Laboratory Technicians.
- **Sample Population:** A total of 140 medical laboratory technicians in all departments including, (biochemistry, microbiology, parasitology, hematology, blood bank, and pathology) were recruited for this study using a systematic random sampling technique. The sample size was estimated using the table of Krejcie & Morgan (1970) for determining sample size for the known population.Using this table, a sample size was 103 laboratory technicians.
- **Study Tools**

a) Questionnaire: was made to obtain relevant information from the study participants about:

i. Demographic details, general characteristics of the participants were collected in the first part of the questionnaire.
ii. Ergonomic details, some information regarding ergonomic design, provision of some ergonomic instruments and etc.
iii. Health problems, types, severity or intensity, area of pain and etc.

b) RULA employee Assessment Sheet: the posture analysis amongst laboratory technicians was performed using Rapid Upper Limb Assessment (RULA) (Appendix 3).The Rapid Upper Limb Assessment method was developed by Dr. Lynn McAtamney and Professor E. Nigel Coelet, ergonomist from the University of the Nottingham in England. This assessment provides a quick and systematic assessment of the postural risk to a worker. It also was used to evaluate awkward postures of laboratory technicians in standing and sitting position. Each participant was observed in order to select the static posture which he/she maintain for long period of time during the laboratory work. With help of RULA employee worksheet, each participant was given a score on dominant and non-dominant side respectively. Base on participants' RULA scores, the ergonomic risk for development of musculoskeletal injuries was then assessed.[8]

Interpretation of RULA Score

(1-2) posture is acceptable if it is not repeated for a long time.

(3-4) further investigation is needed and changes may be required.

(5-6) further investigations and changes are required soon.

(7) Further investigations and changes are required immediately.

- **Inclusion Criteria:** Medical laboratory technicians in BMC who have been working for more than a year.
- **Exclusion Criteria:** Study subjects who already might having any congenital musculoskeletal or neurological malformation that has not been acquired due to the job.
- **Period of Study:** almost 4 months. Data collected from January to April 2017.
- **Ethical Approval:** The study was approved by Benghazi Medical Centre Research Board (REB). Written consent form to the interested participants was provided as they were informed that their participation was completely voluntary and not asked any questions about their identity. Request for Exemption from REB Review was also filled at BMC by researchers before start data collection.
- **Data Analysis Plan:** Data were analyzed by using SPSS 22 version Software program.

5. RESULTS

This study involves a total of **103** laboratory technicians, in the age group of (20 to 50) years. Out of all study participants, 69 % are Females and 31% are Male. Also, the majority of study participants are highly graduated with 88% for Bachelor degree and 6.7 % for post graduated. The majority of study participants are also from the department of Blood Bank. The collected data and Rapid upper limb assessment study present that all the study participants are at ergonomic risk due to static working postures during performing laboratory tasks. Results also presents that 5.8 % of the study participants are Left handed and the rest are Right handed. Data outcome in Figure (1) also presents that 62 (60 %) study participants work more than 6 hours per day, 41 (40 %) participants' works for less than 6 hours per day. Data outcome in Figure (2) shows that 36 (58 %) out of 62(60 %) study participants work more than 6 hours per day and 23 (37 %) study participants work more than 6 hours per day. In addition, Figure

(3) presents that 6 (5.8%) are Left Handed workers and 97 (94.2%) are Right Handed workers. Figure (4) also presents that 88% do not engaged any sport activities in their daily life. Figure (5) moreover, shows that 67 (65%) suffering pain, 14 (13.6 %) suffering stiffness and 22 (21.4 %) suffering fatigue. While Figure (6) shows that 58 % of workers who suffering pain refers their pain to high pain severity. On the other hand, data outcome presents that 94% of medical laboratory technicians do not conduct any safety training program. Furthermore, Table (1) shows the areas of pain as 46.3% suffer from low back pain, 14.9% suffer shoulder pain, 13.4% suffer arm pain and 1.5% suffer legs pain.

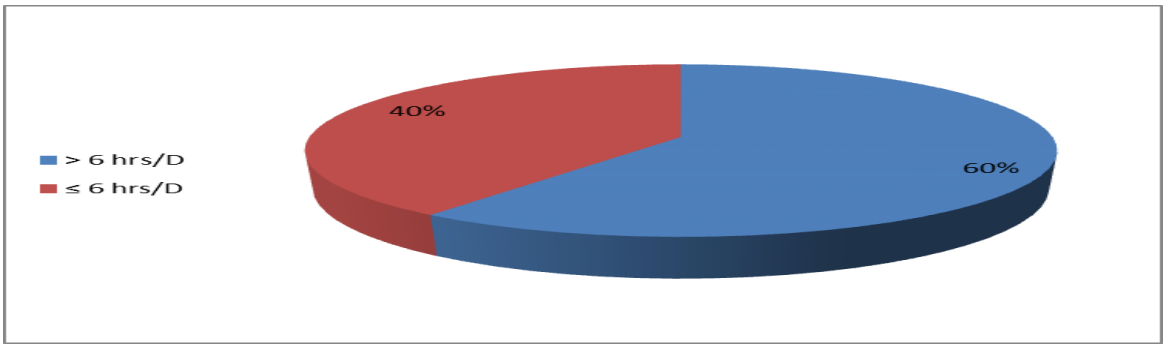

Figure (1): Distribution of Working hours per day among Medical Laboratory Technicians

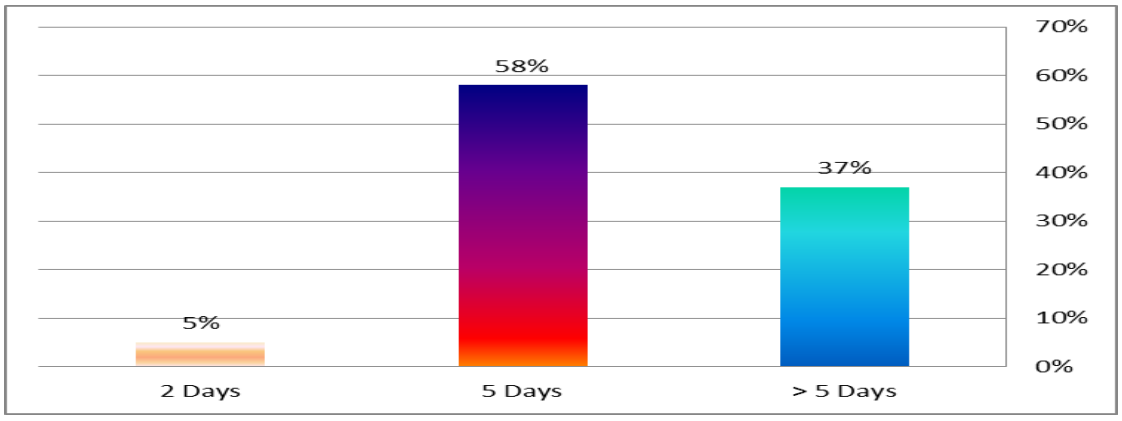

Figure (2): Distribution of Working Days per Week among study participants works more than 6 hours per day

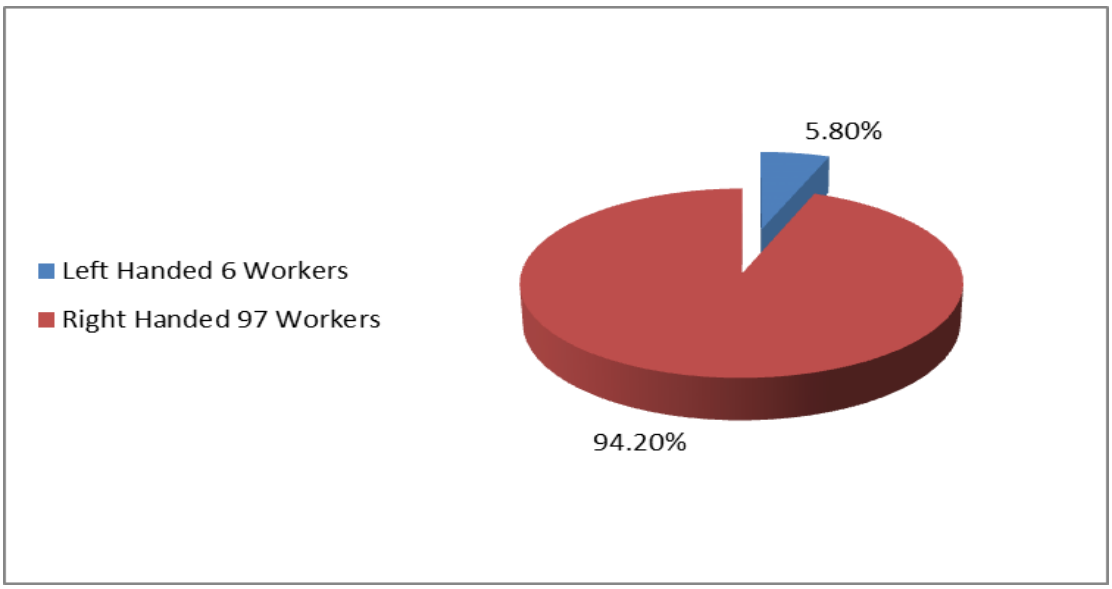

Figure (3): Distribution of Left and Right Handed among Medical Laboratory Technicians

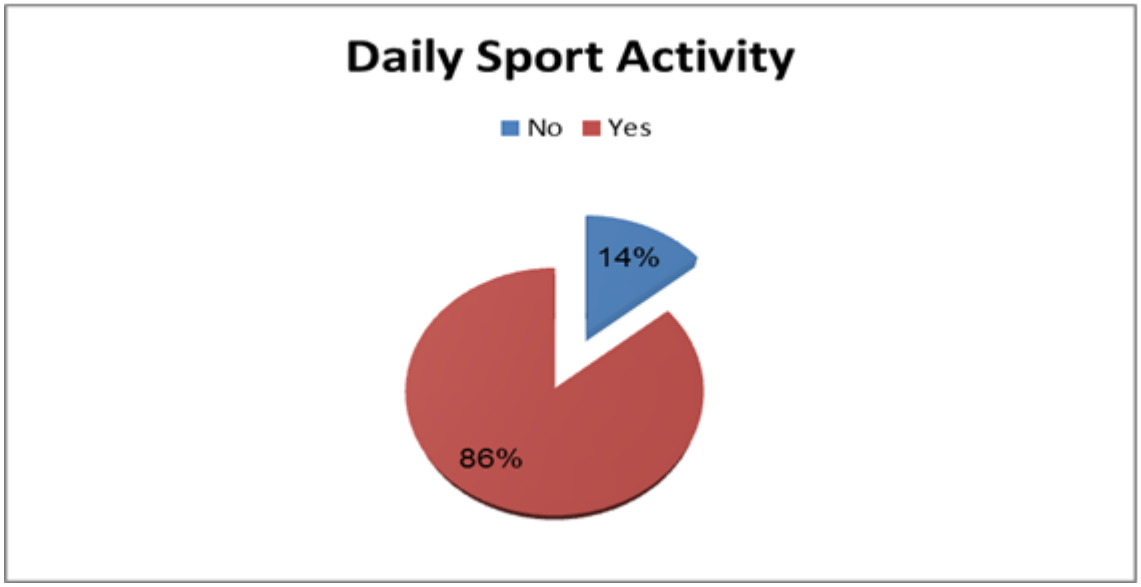

Figure (4): Distribution of Personal Daily Exercising among Medical Laboratory Technicians

Figure (5): Distribution of Work-related Musculoskeletal Disorders among Medical Laboratory Technicians

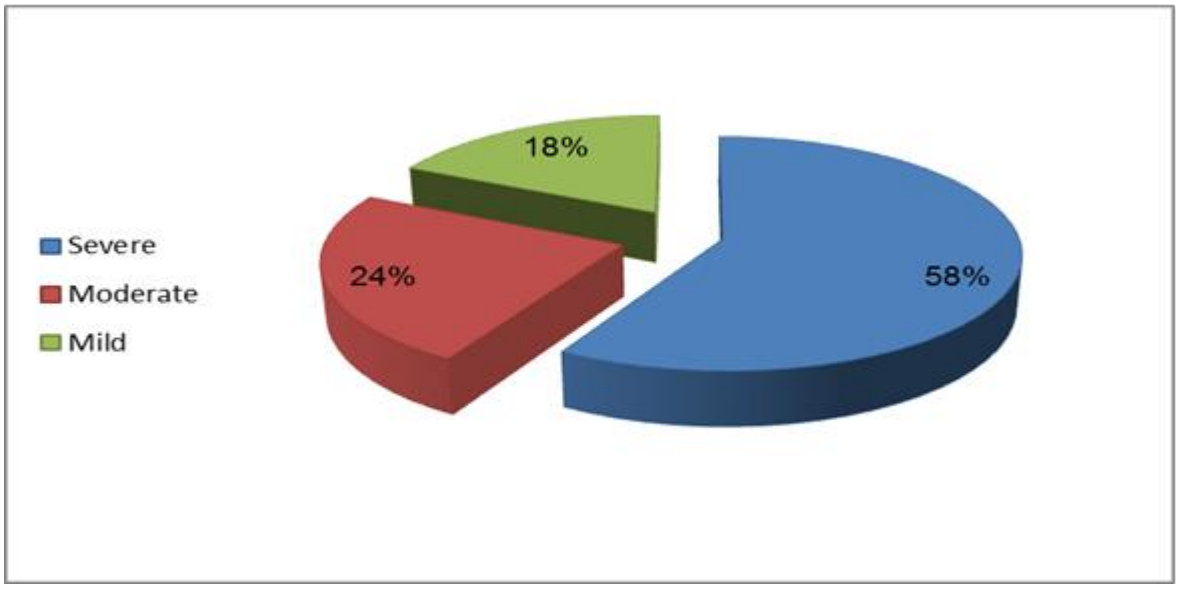

Figure (6): Distribution of Pain Severity among Medical Laboratory Technicians

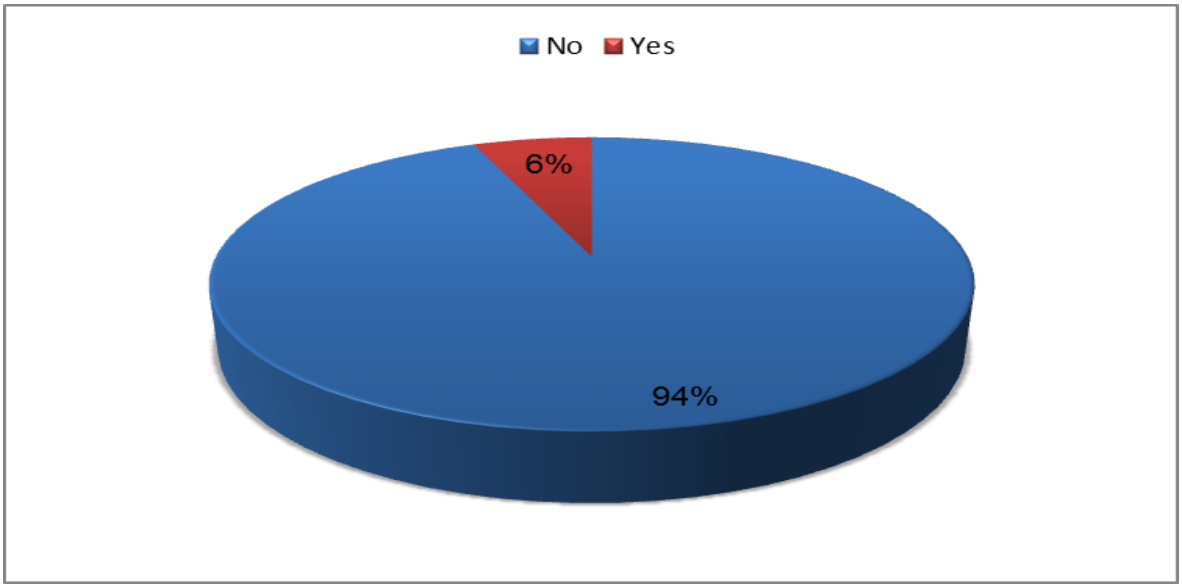

Figure (7): Distribution of Provision Training Program among Medical Laboratory Technicians

Table (1): Distribution of Areas of Pain among Medical Laboratory Technicians

Areas of Pain	Number of Participants	Percentage %
Lower Back	31	46.3
Shoulder	10	14.9
Neck	9	13.4
Wrist	5	7.5
Arm	8	11.9
Heel	3	4.5
Leg	1	1.5
Total	67	100%

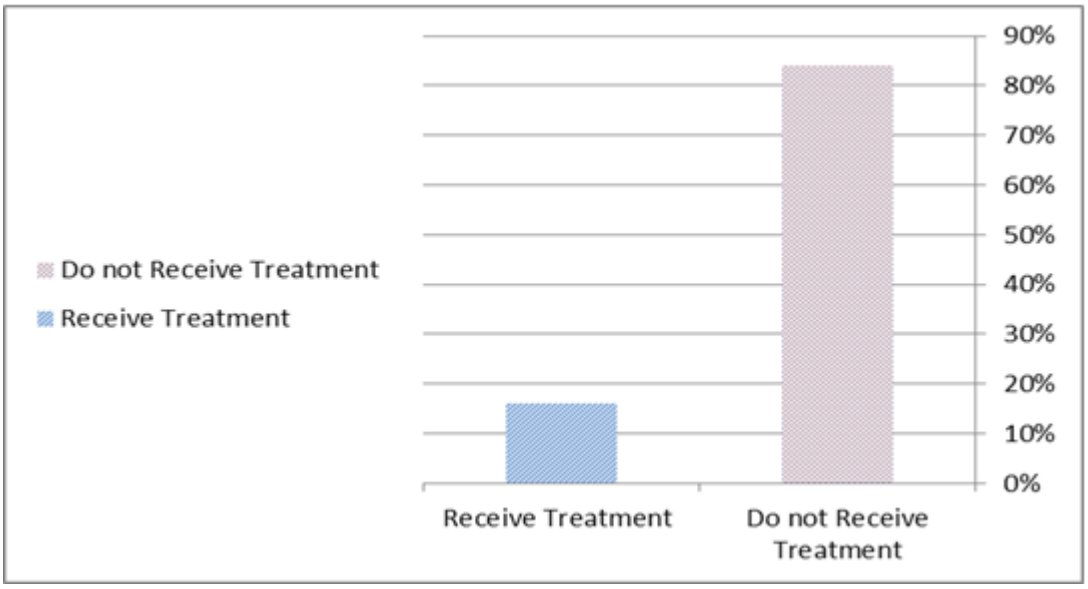

Figure (8): Distribution medical laboratory technicians who are received Treatment for WMSDs.

Table (2): Determine the Ergonomic Issues at Workstations

Ergonomic Details	Percent %	
	Yes	No
Are primary work tools and supplies located within arm's reach from table edge?	58	42
Is there knee and foot clearance when completing standing tasks in front of the bench?	73	27
Are there floor mats(foot rests) in areas where prolonged standing tasks?	87	13
Does the bench have rounded or padded edges (arm rest) to reduce contact stress?	94	6
Do YOU know how to adjust chairs?	93	7
Can YOU view the eyepiece with neutral neck, shoulder and back postures?	66	34
Are arms supported by work surface, chair armrests, or pads for prolonged work?	59	41
Is there sufficient legroom and foot support when using the microscope?	78	22
Is manual pipette use limited to less than 4 hours per day?	97	3

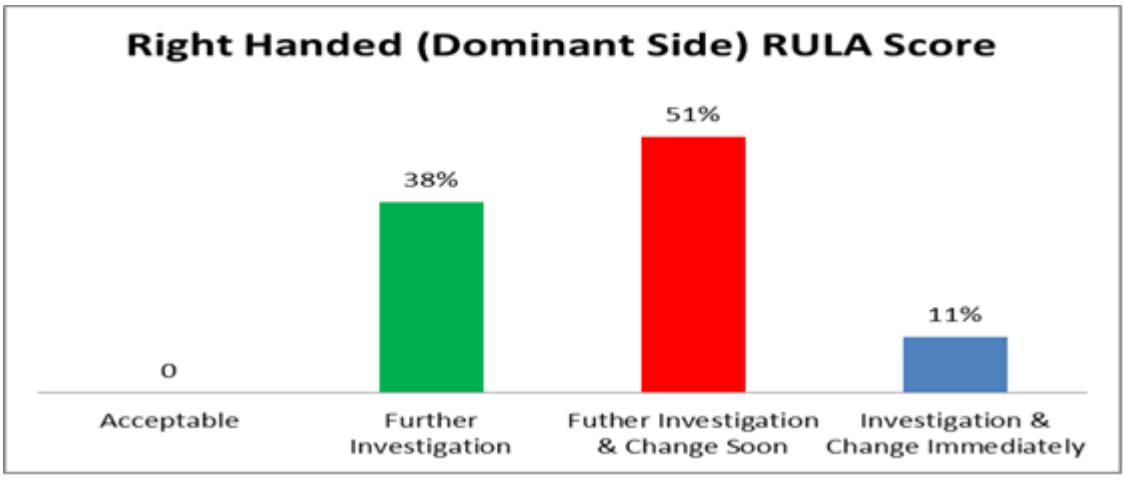

Figure (9): Distribution of Dominant Side RULA Score among Right-handed Medical Laboratory Technicians

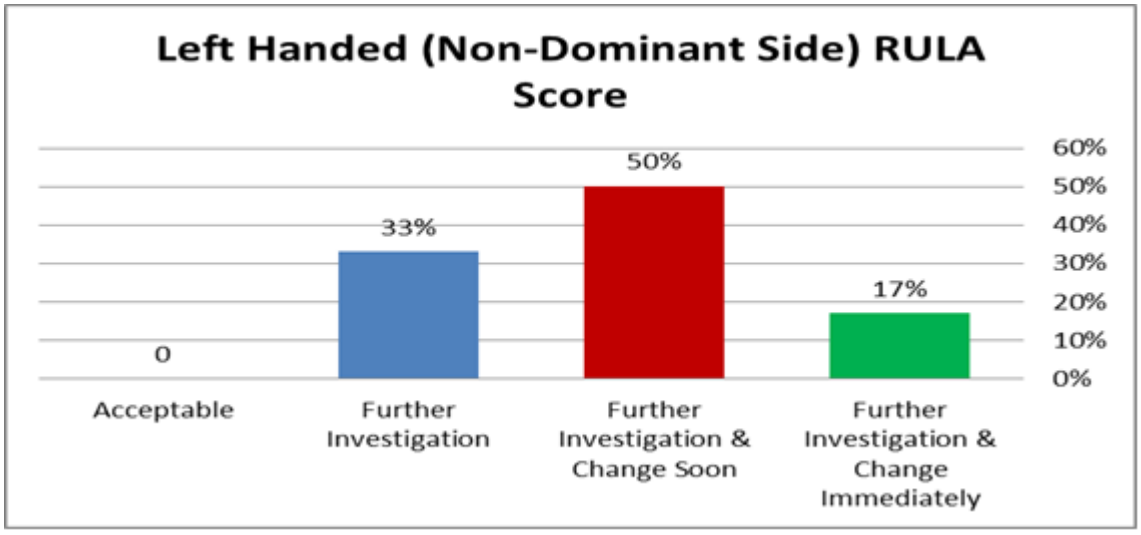

Figure (10): Distribution of Non-Dominant Side RULA Score among Left-handed Medical Laboratory Technicians

6. DISCUSSION

Laboratory services are an essential and fundamental part of all health systems. This project aimed to determine risk for development of work-related musculoskeletal disorders amongst (103) medical laboratory technicians, in the age category of (20 to 50) years. Data collected through questionnaire and RULA Checklist, study displays that all the study participants are at ergonomic risk caused by static & repetitive working postures during laboratory tasks such as computer workstation and pipetting workstation that were found to be the most important contributory factors in WMSDs. Amongst all study participants, 69 % are females and 31% are males. Also, this study shows that about 6 % of the study subjects are Left handed by dominance and rest are Right handed by dominance. As most of those technicians are designed as per the convenience of right-handed dominant people so, it suspects increasing probabilities of getting prone to work-related repetitive motion injuries are more in left-handed medical laboratory technicians. In addition, the study argues that 51% of the study participants have RULA Score 5 and 6 on the dominant side which indicates further investigation and soon changes in static working postures of technicians. On the other hand, 11% study participants have RULA Score 7 that point to an immediate change in static working postures of technicians. However, on Non-dominant side, 50% study participants have RULA Score 5 and 6 that refers further investigation and soon change in static working postures of technicians and 9% of the study participants have RULA Score 7 that point to an immediate change in static working posture of those technicians. Another study conducted in the Philippine Science High School - Main Campus, shows that 86% of Grade 11 students have an environmental complaint on their chemistry laboratory. It has been evaluated through RULA/REBA techniques that 100% of common laboratory postures are unacceptable. Through additional analyses on the anthropometrics of the furniture and the environmental conditions in the laboratory, it has been established that overall ergonomic considerations for the Filipino senior high school students have been lacking. Accordingly, the study suggests applying the immediate change in laboratory design which features ergonomic laboratory tables, cabinets, white board and light and temperature control system.[10] working in awkward postures and long duration repetitive motions can rise the force and level of exertion and can lead to stress the joints as well as reduces blood flow. Moreover, pipetting task needs thumb force when pressing plungers, repeated hand, thumb, finger and forearm motion, wrist twisting, neck bending, standing for a longer time. Furthermore, technicians have to repeat thousands of wrist and hand movements during the day while they work on the microscope that usually requires prolonged flexion of back and neck, raised shoulders, elbow abduction, awkward wrist and hand postures. Most these risk factors rises stress on the lumbar spine and entire body.[9] OSHA (2011) mentioned that employers should recognize that laboratory workers are at risk for repetitive motion injuries during routine laboratory procedures e.g.; pipetting, working at microscopes, operating microtomes, using cell counters and keyboarding at computer workstations. Repetitive motion injuries develop over-time and occur when muscles and joints are stressed, tendons are irritated, and nerves are strained and blood flow is limited.[8] However, the study also presents that foot and arm rests while working on microscope and computer are not provided. Accordingly, not using foot and arm rests while performing tasks are prone to getting strain and increased the muscle activity.[2]

In addition, 97 % of study participants complained that manual pipette does not use limited to less than 4 hours per day. It refers to increasing stress and strain on fingers that can increase the chance of carpal tunnel syndrome exposure. This study also showed that 16 % of study participant's follows treatment for work-related musculoskeletal problems so this can indicate lack of awareness regarding work-related ergonomic risk amongst study participants those who are not taking any treatment. Study additionally reveals that those laboratory technicians reported that they never heard about laboratory ergonomics and neither even received ergonomic safety training before and after conducting their work. On the other hand, it is found that most of the study participants do not have time to exercise in their daily routine that can decrease the muscle tolerance and recovery of fatigue or pain as the sport can enhance the body health and performance. Additionally, a study was conducted among 279 laboratory technicians at King Fahd Hospital, Saudi Arabia, who filled in a self-administered questionnaire, and symptoms suggestive of Carpal Tunnel Syndrome (CTS).The prevalence of CTS among the laboratory technicians was 9.7% (27/279). The following were the statistically significant risk factors for CTS among them pipetting (OR: 7.27; 95% CI: 3.15–16.78).

7. LIMITATIONS

There were several challenges in this project that had affected the accuracy of this project, these are as the following:

1) Time of the study was very short that had a big impact on the study.
2) The samples were collected only from BMC, so the result of this study could not be generalized to the whole population of medical laboratory technicians in Benghazi city in Libya.
3) Designing questionnaire in English that make some misunderstanding from technicians.
4) No research has been done before on this topic in Libya, so there was little evidence to support the result of this project in the context of Libya.

8. CONCLUSION

On basis of the Rapid Upper Limb Assessment (RULA), the majority of the participants were exposed to ergonomic risk factors including, (awkward postures, high frequency, and static muscle work) for development of work-related musculoskeletal disorders. It is additionally concluded that the majority of participants are not aware of ergonomic at the workplace. Moreover, it is found that majority of the participants do not specify a time to exercising in their daily routine. To minimize work-related musculoskeletal disorders, Laboratory Personnel should reposition tools and bring about certain modifications at the workstation so that, technicians are within close reach. For Instance, modification of bench surfaces to increase knee & foot clearance, use of foot rest and adjusting arm rest to support shoulders in a neutral position. It is also necessary to work to adjust postures, seat height, seat angles, use of arm pads, and reposition of the microscope, consider the use of alternative pipettes and so forth. Ergonomic advice on an annual basis from the field of experts to all the workers at the workstation is highly recommended. To sum up, applying ergonomic modifications and engineering control in a medical laboratory environment can significantly decrease fatigue and discomfort, improves morale and motivation.

9. RECOMMENDATIONS

Healthcare laboratory technicians are often highly exposed to work-related musculoskeletal disorders (WMSDs) during performing their laboratory tasks, in order to eliminate or minimize this exposure as possible as we can, this project comes out with the following recommendation involving:

- Help medical laboratory technicians to develop a positive attitude towards safety as they should not be fearful of doing experiments or using equipment, but they should always be alert for potential hazards by providing suitable safety training courses.
- Should always demonstrate new procedures before allowing medical laboratory technicians to begin the work activity.
- Look for possible new hazards and alert medical laboratory technicians to potential dangers by periodic monitoring risks/hazards at the workplace.
- Explain and post ergonomic safety instruction inside the labs.
- Ensure that all medical laboratory technicians have understood the ergonomic safety instructions and keeping them up to date.
- Ensure that all medical laboratory technicians know about the ergonomic risks/hazards that come from their workplaces, tasks, equipment and etc.
- Maintain constant supervision of medical laboratory technicians activities regards getting the workspace set-up as the following:

    i. Take time to set-up properly and adjust your chair/tool to fit you comfortably.
    ii. Adjust the workstation height to the task you are carrying out.
    iii. Use the swivel in your chair to decrease body twisting.
    iv. Change working positions frequently.
    v. Always face the object of work.
    vi. Keep your body close to your work.
    vii. Keep trays and other supplies that you use frequently in close reach.
    viii. Adjust the workstation or your chair to avoid working with your arms elevated.
    ix. Take regular breaks and apply stretching exercise.

Finally, applying ergonomic modifications and engineering control in a laboratory environment can significantly minimize ergonomic hazards.

10. REFERENCES

[1] Waldron HA, Occupational Health Practice, 3rd ed. Butterworths, London; 1989.
[2] Arora A et al., Ergonomic risk assessment in pathology laboratory technicians, *International Journal of Therapies and Rehabilitation Research*, 2015; 4 (3): 15-19.
[3] Lawal AL, Obasaju B, Rotimi EM. Towards achieving millennium development goals (Mdg) in Nigeria: Prospect and challenges. *J Econ Sustain Dev*. 2012; 3:74–83.
[4] Oladeinde BH, Omoregie R, Osakue EO, Onifade AA. Evaluation of laboratory request forms for incomplete data at a rural tertiary hospital in Nigeria. N Z J Med Lab Sci. 2012; 66:39–41.
[5] Oladeinde, BH et al. "Awareness and Knowledge of Ergonomics among Medical Laboratory Scientists in Nigeria." *Ann Med Health Sci Res*. 2015 Nov-Dec; 5(6): 423–427.
[6] Five ways to improve ergonomics in the laboratory. E-book www.humantech.com
[7] McAtamney, L. & Corlett, E.N. (2004) Rapid Upper Limb Assessment (RULA) In Stanton, N. et.al. (Eds.) Handbook of Human Factors and Ergonomics, 24, 91-99. chapter7, Boca Ratoon FL.pp, 7:1 – 7:11 Bureau of labor statistics, U.S. Occupational Outlook Handbook, 2014-2015 Edition.
[8] OSHA 2011, Laboratory Safety Ergonomics for the Prevention of Musculoskeletal Disorders, accessed on 23 May 2017.
[9] USDA APHIS, APHIS Ergonomics Program, http://www.aphis.usda.gov/mrpbs/emssd/ergonomics.shtml
[10] Santiago et al. An Ergonomic Design of Senior High School Science Laboratories in the Philippines. AHFE 2017. Advances in Intelligent Systems and Computing, vol: 588: 869-881.
[11] Agrawal et al. 2017, Risk factors for work-related musculoskeletal disorders among medical laboratories professionals, *International Journal of Medical Science and Public Health*, Risk factors for work-related musculoskeletal disorders among medical laboratories professionals, Issue 3, Vol 6: 530-538.
[12] El-Helaly et al. 2017, Carpal Tunnel Syndrome among Laboratory Technicians in Relation to Personal and Ergonomic Factors at Work, *Journal of Occupational Health*.
[13] Mitchell T. 2014, .Laboratory ergonomics: Microtome's, cryostats, cell counters, micro manipulation, and lifting and glove boxes.*occup.J*.Vol.5:22_24

